Threshold Behavior in Kinetic Electron Emission from MgO and SiO_2

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Ion-induced secondary electronic emission(IISEE) from solids is related to phenomena such as plasma-wall interaction, ion detection, and microscopy. Electronic transitions, hot carrier relaxation, and carrier transport in the bulk which are involved in IISEE are the subjects of fundamental interest in physics. Though kinetic emission (KE) in metals has been extensively investigated both theoretically and experimentally, almost no similar study has been made forinsulators due to the experimental difficulties associated with surface charging problem.

We have accurately measured the of the MgO and SiO_2 for various noble gas ions under negligible surface charging conditions using pulsed ion beams (Fig.1). In contrast to metals, MgO and SiO_2 show efficient KE even at low ion energies and a well-defined threshold energy. When expressed in the binary collision energy, the threshold energy exactly coincides with the surface ionization energy of a given insulator. From the threshold behavior analogous to that in the gas-phase ion impact ionization, we propose for the first time the that KE in insulators occurs by direct excitation of the localized O-2p electron in a close binary collision via the Pauli exclusion type of repulsive interactions among the valence electrons of the neutralized projectile and the O^{2-} anion. The ion- and insulator-dependent potential emission will also be explained in terms of the energetic condition and the electron escape probability.

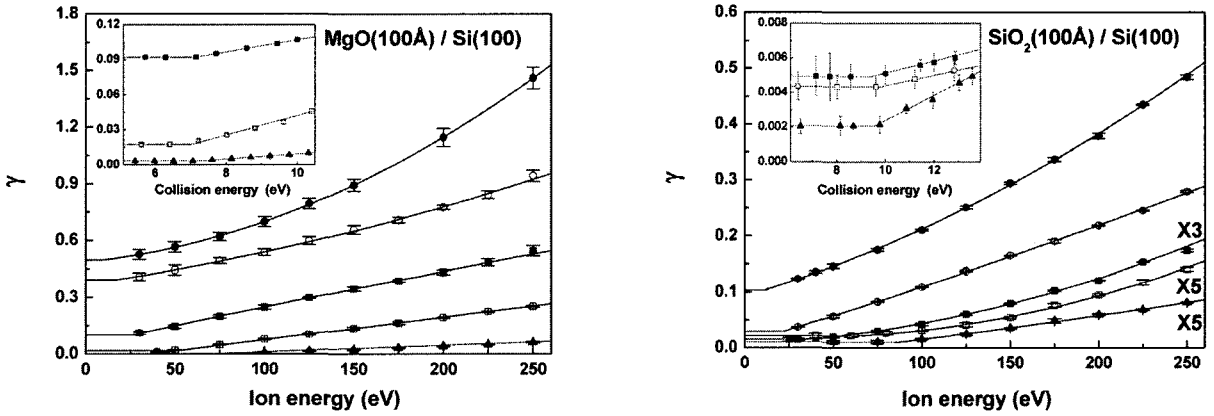

Fig1. The of MgO and SiO2 for variousnoble gases. The inlet shows the KE threshold energies for He+(●), Ne+ (○), Ar+ (■), Kr+ (□), Xe+ (▲)